LARGE-SCALE DRIVERS OF CLOUD, ATMOSPHERIC STRUCTURE, AND SURFACE VARIABILITY IN ALASKA USING SELF ORGANIZING MAPS

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Background

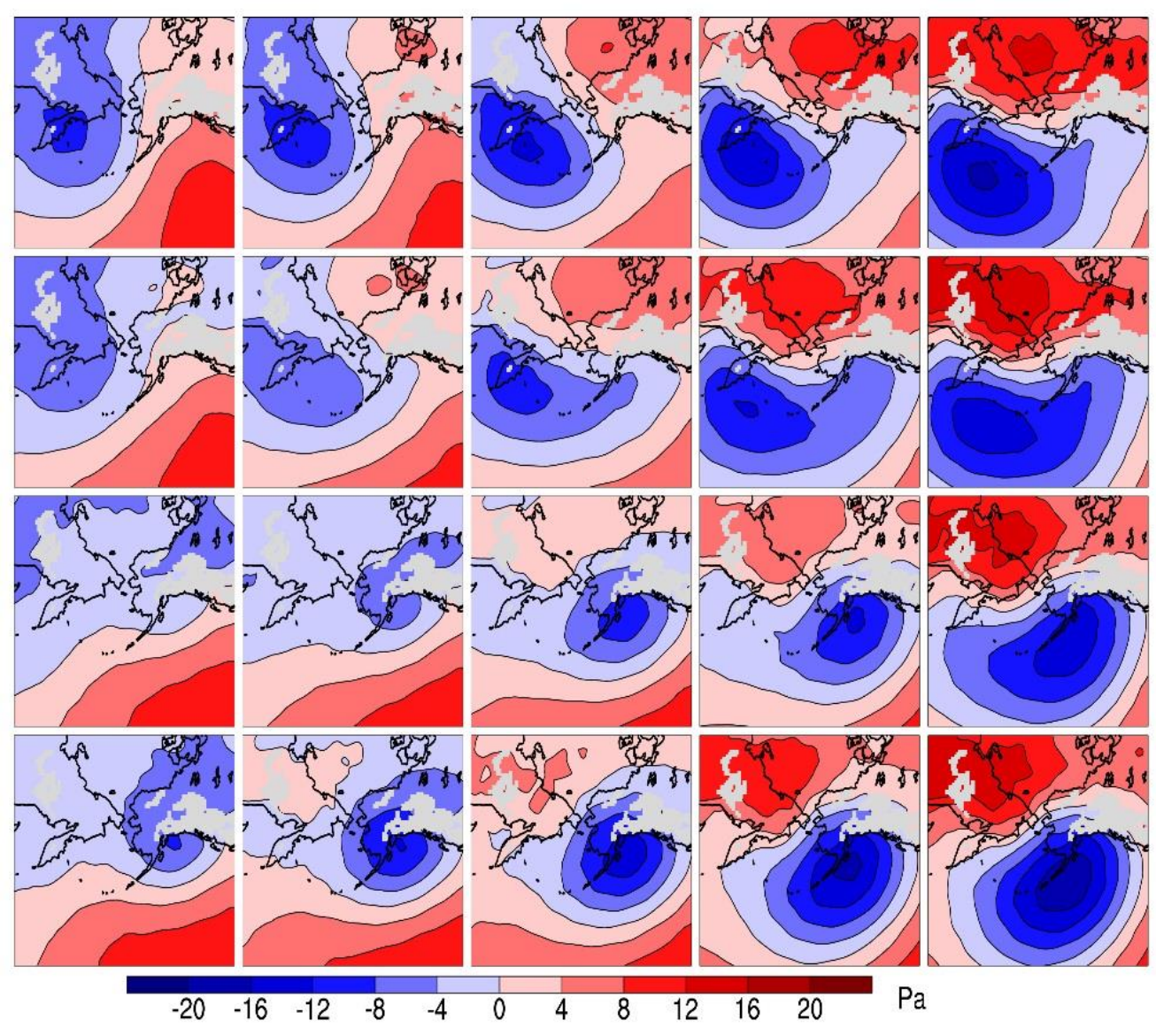
Self Organizing Maps

- Groups similar data vectors into generalized patterns ("nodes")
- Nodes closer to each other are similar, distant are dissimilar
- Input: daily SLP anomaly patterns from NCEP-NCAR reanalysis
- Output: grid of generalized patterns and day list for each node

Data Used Here

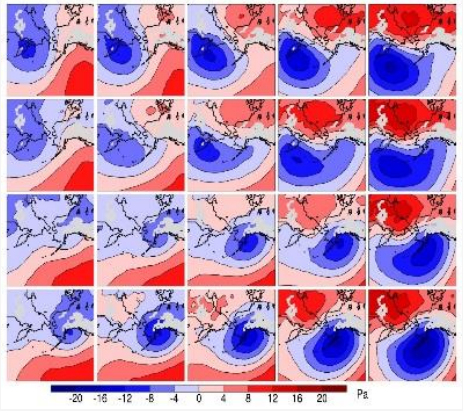
- Oliktok: 9/2013 – 6/2017
- Barrow: 1/1998 – 6/2017
- Seasonal background subtract

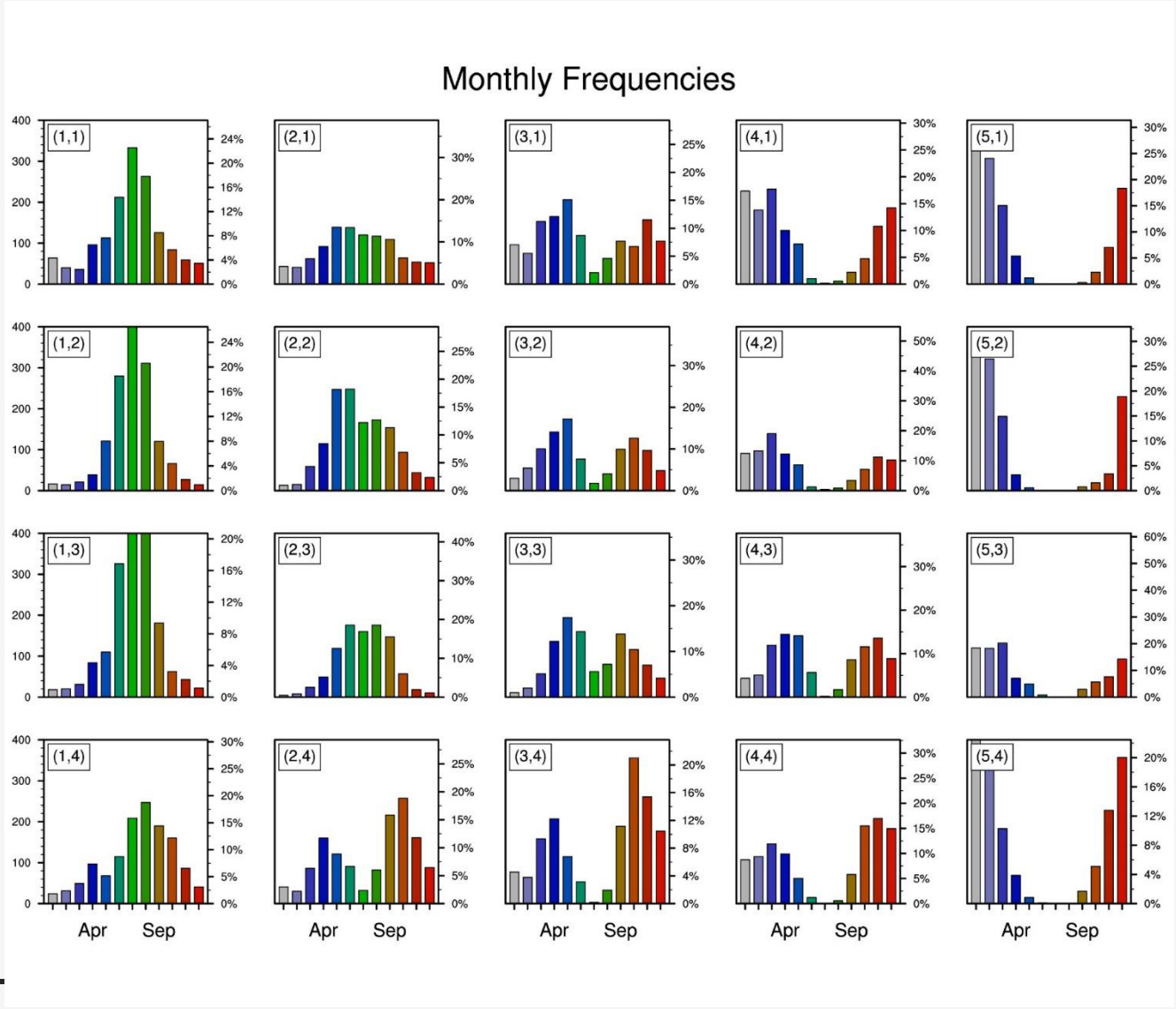
Master SOM



5x4 is a trade-off between uniqueness and statistical robustness

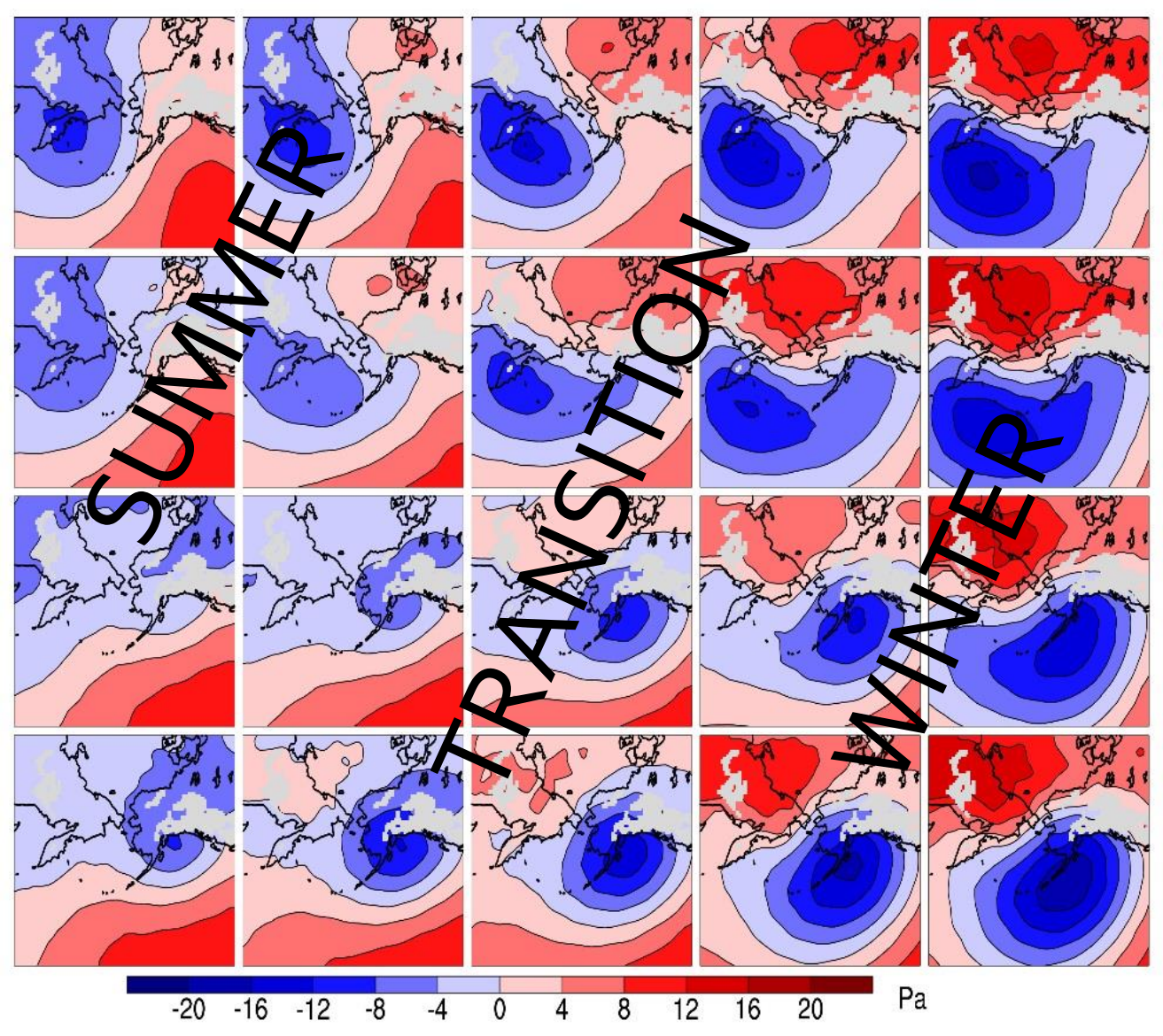
Seasonal Occurrence



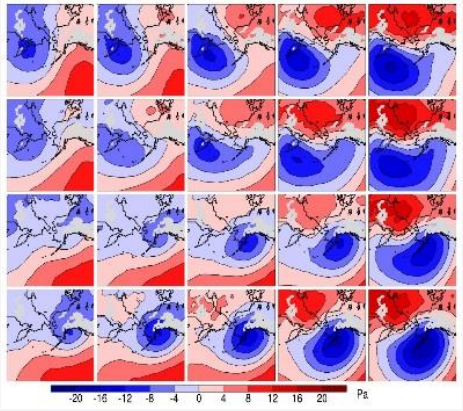


Summer >>> Transition Seasons >>> Winter

Master SOM



Pressure



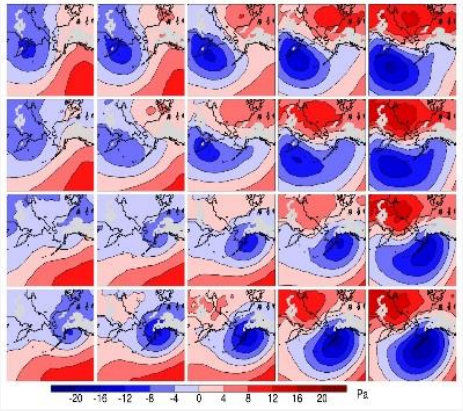
Barrow, Pressure [mb]

	A	B	C	D	E
1	1025.8 **1013.4** 8.2 274 998.8	1026.4 **1016.2** 7.2 238 1004.0	1033.9 **1021.4** 8.3 258 1006.9	1037.7 **1024.3** 9.4 235 1009.3	1043.2 **1024.5** 10.6 216 1008.2
2	1023.5 **1013.5** 6.6 293 1001.3	1023.7 **1015.5** 6.3 266 1003.8	1033.6 **1020.1** 8.5 198 1007.1	1035.9 **1023.0** 8.9 157 1007.6	1042.4 **1025.0** 10.3 231 1008.1
3	1024.8 **1011.3** 7.6 380 999.3	1020.1 **1010.7** 6.2 203 999.6	1024.1 **1014.4** 6.1 223 1003.8	1036.5 **1019.4** 8.7 209 1007.2	1040.1 **1022.5** 8.9 136 1009.1
4	1019.6 **1006.5** 7.9 247 993.1	1018.5 **1005.8** 8.3 283 990.7	1023.1 **1008.5** 8.8 346 992.2	1022.5 **1009.8** 8.8 245 995.7	1031.7 **1014.3** 9.8 350 998.9

Oliktok, Pressure [mb]

	A	B	C	D	E
1	1027.5 **1015.3** 8.3 73 1000.8	1027.7 **1018.0** 7.8 66 1004.3	1035.4 **1021.7** 9.5 77 1007.8	1038.9 **1024.7** 9.8 85 1006.7	1034.0 **1022.4** 7.5 48 1006.1
2	1022.1 **1012.8** 5.2 61 1003.4	1022.9 **1013.9** 5.9 71 1002.7	1032.4 **1016.6** 8.6 49 995.8	1035.6 **1021.9** 8.4 47 1007.4	1035.3 **1020.8** 8.9 56 1006.5
3	1023.0 **1011.7** 7.2 120 999.7	1019.4 **1010.0** 6.2 48 995.8	1024.0 **1013.3** 6.0 67 1002.1	1030.7 **1018.7** 7.1 47 1007.1	1042.4 **1024.9** 9.5 44 1010.9
4	1015.8 **1005.7** 7.6 59 995.0	1016.5 **1004.3** 8.1 55 988.0	1017.9 **1007.2** 7.8 94 991.1	1021.9 **1010.0** 7.5 69 995.0	1028.9 **1012.5** 9.1 141 997.1

Cloud Frac



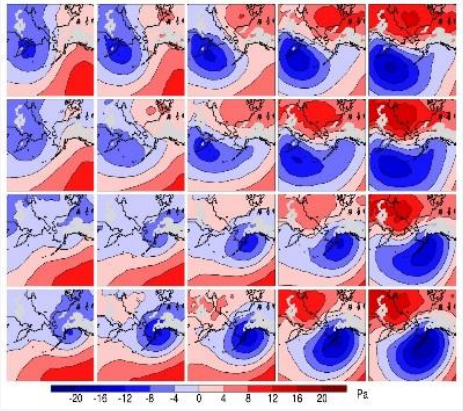
Barrow, Cloud Fraction (ceilo) [%]

	A	B	C	D	E
1	100.00 73.21 29.67 346 4.94	100.00 74.59 27.59 279 15.60	100.00 64.41 35.60 342 0.30	100.00 57.36 34.63 298 0.26	100.00 55.35 35.33 300 0.30
2	100.00 80.91 27.41 379 11.65	100.00 75.70 30.35 335 5.46	100.00 69.07 35.47 242 1.15	100.00 63.29 34.00 182 3.20	100.00 58.42 33.84 306 0.26
3	100.00 82.19 26.02 502 15.76	100.00 84.40 24.72 260 20.59	100.00 78.97 30.11 274 5.08	100.00 73.95 32.26 262 2.09	100.00 59.85 34.83 162 0.80
4	100.00 87.76 20.48 315 34.70	100.00 85.63 24.52 350 23.81	100.00 82.35 27.09 431 16.63	100.00 74.29 31.82 311 5.94	100.00 65.98 33.32 458 3.24

Oliktok, Cloud Fraction (ceilo) [%]

	A	B	C	D	E
1	100.00 73.99 26.58 74 10.41	100.00 68.48 32.04 66 3.71	100.00 66.37 36.59 75 0.02	100.00 62.23 31.34 80 3.80	100.00 52.14 34.60 48 0.02
2	100.00 81.60 24.97 62 21.87	100.00 75.26 30.76 69 0.28	100.00 71.43 32.65 49 9.07	99.85 61.07 31.58 47 0.02	100.00 63.04 34.29 53 1.96
3	100.00 78.70 26.41 120 16.81	100.00 78.22 25.74 50 24.64	100.00 84.99 24.09 64 24.00	100.00 77.22 30.29 45 5.86	100.00 64.32 32.95 42 0.06
4	100.00 82.88 25.50 56 12.12	100.00 86.08 22.26 52 41.45	100.00 79.30 29.12 94 13.23	100.00 70.28 32.67 67 0.56	100.00 63.30 33.69 136 2.83

Temperature Anom



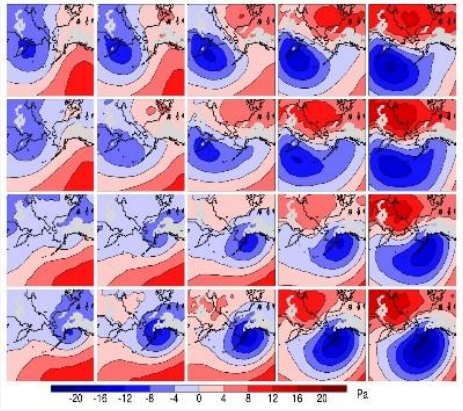
Barrow, Temperature Anomaly [C]

	A	B	C	D	E
1	11.68 2.70 5.05 274 −3.71	11.92 2.77 4.78 238 −3.55	10.89 2.16 5.08 258 −5.70	12.33 0.90 6.51 235 −8.91	10.69 −0.47 6.51 216 −9.83
2	6.14 0.55 3.44 292 −4.27	6.20 0.26 3.38 263 −4.61	7.32 −0.54 4.59 198 −8.72	7.76 −0.29 5.13 156 −8.81	7.90 −0.86 5.28 231 −9.65
3	5.40 −0.18 3.26 380 −4.64	4.15 −0.17 3.05 203 −3.96	4.62 −0.86 3.22 223 −6.73	6.18 −1.21 4.32 209 −9.63	6.89 −1.13 5.15 136 −10.43
4	4.24 −0.83 2.86 247 −5.08	4.36 −1.22 3.71 283 −8.11	6.92 −0.46 4.22 346 −8.86	6.27 −1.37 4.77 244 −10.11	8.77 −0.53 5.79 350 −10.52

Oliktok, Temperature Anomaly [C]

	A	B	C	D	E
1	9.99 2.13 5.11 73 −6.36	9.87 1.52 4.58 66 −7.59	13.27 1.64 5.47 75 −6.71	12.53 1.74 5.66 81 −7.57	8.53 −0.94 6.01 48 −12.86
2	7.94 0.73 4.00 61 −3.52	4.56 −0.44 4.18 70 −6.12	6.21 −0.56 4.70 48 −11.58	7.90 −0.46 5.63 47 −10.08	7.20 −0.88 6.01 53 −11.45
3	6.88 0.01 3.45 120 −4.17	5.21 −0.21 3.11 48 −4.58	3.80 −0.96 3.04 67 −5.64	3.97 −0.68 3.63 47 −9.62	8.28 −1.67 6.50 44 −14.61
4	3.62 −0.41 2.98 59 −4.29	3.85 −0.83 3.66 53 −7.23	5.79 −0.30 4.04 94 −8.41	6.12 −0.47 5.29 68 −11.54	8.10 −0.51 5.97 140 −11.26

LWD Anom



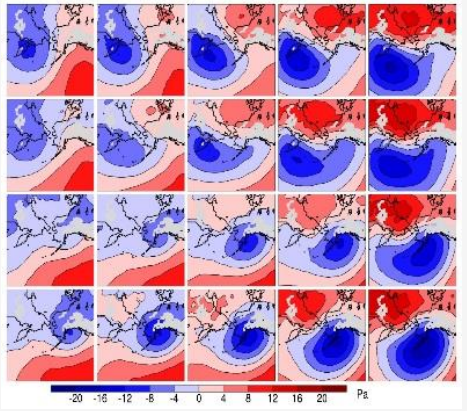
Barrow, LWD Anomaly [W/m^2]

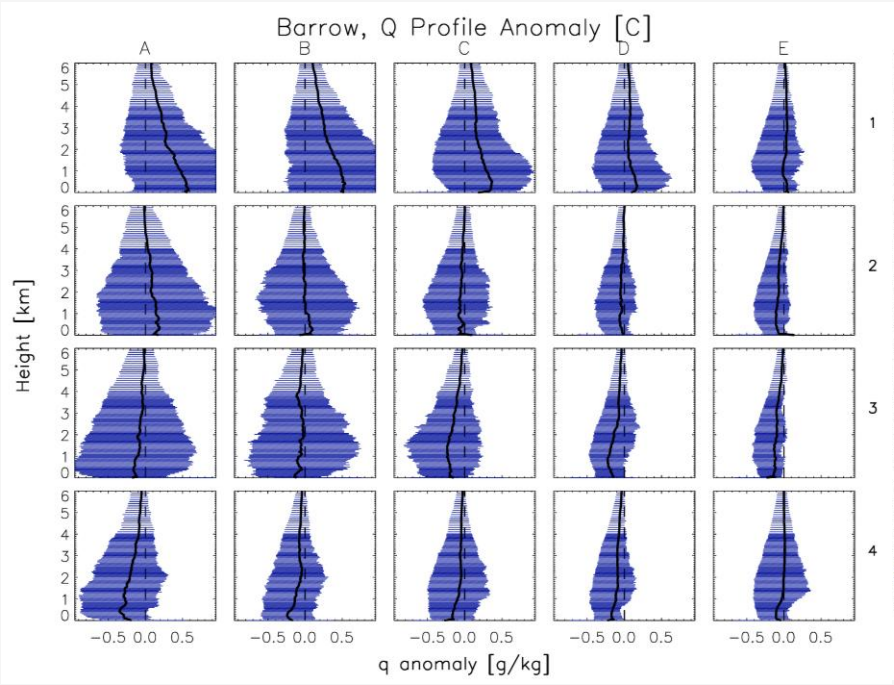
	A	B	C	D	E
1	62.19 **9.42** 29.85 385 −40.03	60.59 **11.33** 30.06 296 −40.02	63.68 **5.90** 34.48 366 −49.99	74.80 **5.74** 37.05 323 −47.88	60.34 **−0.25** 35.26 321 −47.60
2	38.52 **2.72** 24.57 416 −43.35	38.96 **0.13** 26.22 369 −49.21	53.65 **−2.55** 31.09 260 −52.19	50.18 **−5.02** 29.27 200 −51.02	50.92 **−6.96** 31.20 323 −52.20
3	29.03 **−1.28** 21.24 550 −40.63	32.22 **0.80** 21.20 281 −36.61	35.01 **−1.98** 25.61 300 −49.83	42.83 **−3.64** 28.72 277 −51.79	48.26 **−7.36** 30.65 179 −52.07
4	28.45 **−4.55** 23.25 356 −50.52	37.18 **−2.94** 26.28 381 −47.62	45.66 **−0.85** 28.38 494 −51.28	47.58 **−3.06** 31.71 347 −55.21	53.70 **−1.17** 35.18 478 −52.77

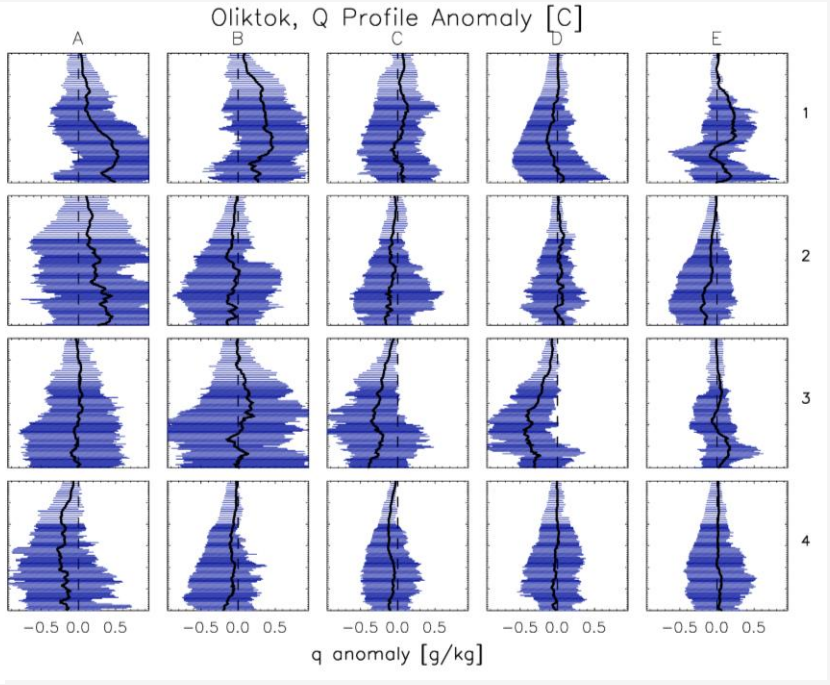
Oliktok, LWD Anomaly [W/m^2]

	A	B	C	D	E
1	46.19 **8.43** 27.11 74 −43.94	48.44 **2.92** 27.80 66 −43.79	49.49 **3.19** 34.35 76 −49.76	63.42 **2.53** 33.10 83 −51.84	55.81 **−9.23** 29.82 47 −53.35
2	40.77 **7.01** 20.62 60 −27.91	31.55 **1.96** 24.92 68 −48.25	49.44 **4.28** 26.16 47 −49.84	28.46 **−10.29** 27.84 47 −53.70	46.96 **−1.36** 32.98 56 −63.06
3	26.71 **−2.17** 20.63 120 −40.77	18.34 **−4.52** 23.58 44 −64.01	25.93 **−0.05** 23.78 64 −50.26	35.73 **−1.30** 22.13 42 −43.38	43.56 **−2.25** 31.59 42 −66.88
4	21.80 **−2.54** 18.64 60 −43.56	34.54 **3.24** 24.65 50 −42.13	40.68 **−0.50** 23.90 91 −45.75	46.73 **−0.27** 30.32 69 −56.37	46.15 **−2.37** 33.70 139 −53.52

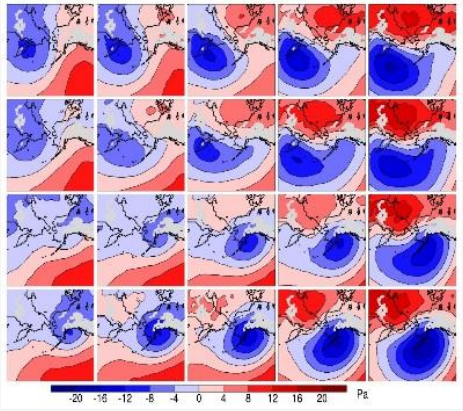
Q profiles


-20 -16 -12 -8 -4 0 4 8 12 16 20
Pa


Barrow, Q Profile Anomaly [C]
A
B
C
D
E
1
2
3
4
Height [km]
0 1 2 3 4 5 6
−0.5 0.0 0.5
q anomaly [g/kg]


Oliktok, Q Profile Anomaly [C]
A
B
C
D
E
1
2
3
4
−0.5 0.0 0.5
q anomaly [g/kg]

Cloud Frac Anom



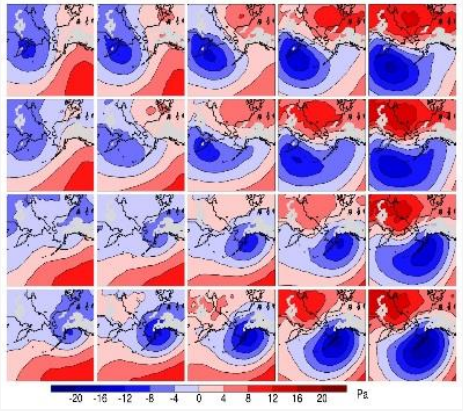
Barrow, Cloud Fraction Anomaly (ceilo) [%]

	A	B	C	D	E
1	30.19 **−5.23** 29.61 346 −69.41	31.27 **−1.87** 27.44 279 −56.11	39.20 **−7.53** 33.46 342 −68.00	41.48 **−5.77** 32.19 298 −59.26	40.35 **−7.03** 33.44 300 −59.03
2	25.91 **0.81** 25.38 379 −61.38	30.99 **−2.61** 28.15 335 −61.32	36.36 **−3.72** 30.27 242 −62.24	40.31 **−1.81** 30.32 182 −56.81	40.87 **−2.99** 32.56 306 −57.92
3	26.83 **2.61** 23.50 502 −53.76	29.11 **2.78** 23.21 260 −55.89	31.00 **1.17** 26.83 274 −59.39	37.23 **3.07** 27.09 262 −51.29	39.12 **−3.24** 30.57 162 −57.80
4	29.81 **7.36** 18.11 315 −29.11	34.14 **5.04** 22.32 350 −45.25	42.30 **6.24** 23.76 431 −44.20	39.14 **4.81** 26.99 311 −52.53	41.15 **1.19** 31.77 458 −56.83

Oliktok, Cloud Fraction Anomaly (ceilo) [%]

	A	B	C	D	E
1	24.11 **−1.38** 25.12 74 −54.81	33.40 **−7.60** 30.98 66 −64.53	41.00 **−7.16** 36.14 75 −75.66	36.18 **−2.99** 30.40 80 −59.96	38.87 **−11.22** 32.87 48 −57.33
2	33.54 **3.86** 22.72 62 −50.20	36.36 **0.33** 27.45 69 −61.52	33.82 **−0.65** 28.45 49 −53.52	30.72 **−6.98** 28.02 47 −60.38	39.28 **1.32** 32.82 53 −57.90
3	21.11 **−0.29** 23.99 120 −62.14	27.15 **−3.13** 26.60 50 −61.91	35.98 **7.40** 22.56 64 −42.01	36.38 **3.83** 23.95 45 −50.50	44.43 **4.07** 30.76 42 −53.28
4	28.79 **2.11** 24.32 56 −60.40	42.68 **7.61** 22.97 52 −30.91	38.19 **5.76** 25.28 94 −50.13	44.66 **4.98** 30.88 67 −58.98	40.28 **−0.68** 31.87 136 −56.82

LWP Anom



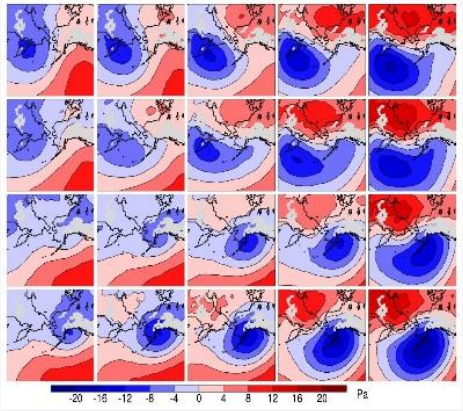
Barrow, LWP Anomaly [g/m²]

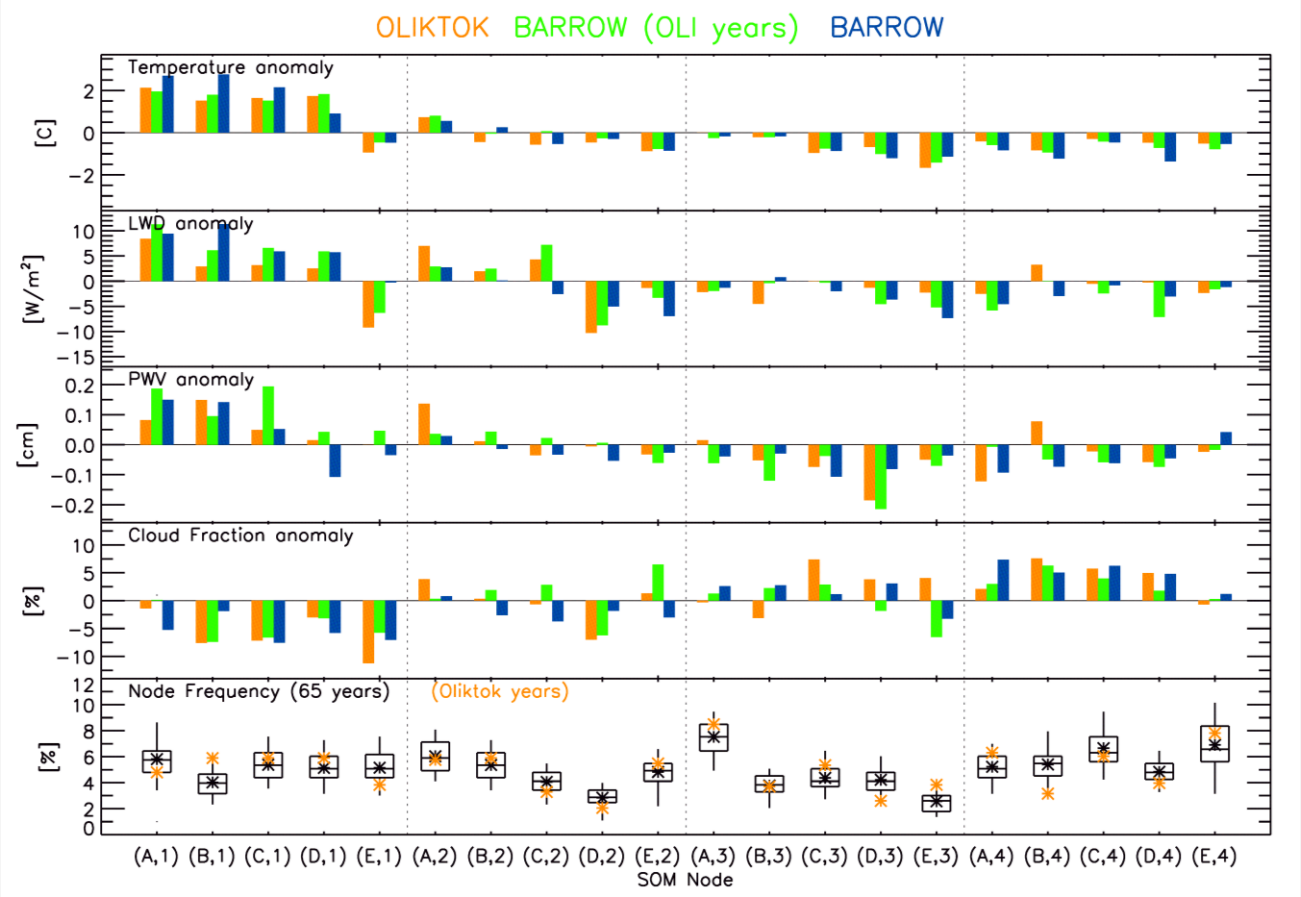
	A	B	C	D	E
1	142.61 **−1.85** 87.46 290 −93.10	91.08 **−7.11** 68.94 247 −87.56	90.45 **−4.18** 71.83 276 −71.80	135.46 **13.09** 94.59 246 −34.50	54.05 **4.13** 65.04 236 −30.72
2	138.96 **1.48** 73.75 339 −75.16	90.50 **−8.80** 61.32 285 −76.88	65.12 **−9.61** 39.85 213 −70.13	59.83 **−1.85** 44.56 144 −50.60	35.40 **−5.44** 20.24 258 −31.60
3	131.12 **1.49** 74.87 435 −73.84	111.57 **1.36** 77.15 230 −82.23	80.07 **−3.48** 47.50 248 −71.21	67.04 **−2.52** 37.90 222 −50.17	78.61 **−0.04** 32.37 148 −34.73
4	131.04 **8.81** 69.83 283 −70.33	120.47 **3.25** 55.39 313 −65.61	92.28 **3.66** 59.65 363 −64.43	88.93 **2.29** 44.26 258 −42.24	54.14 **0.06** 35.70 379 −32.15

Oliktok, LWP Anomaly [g/m²]

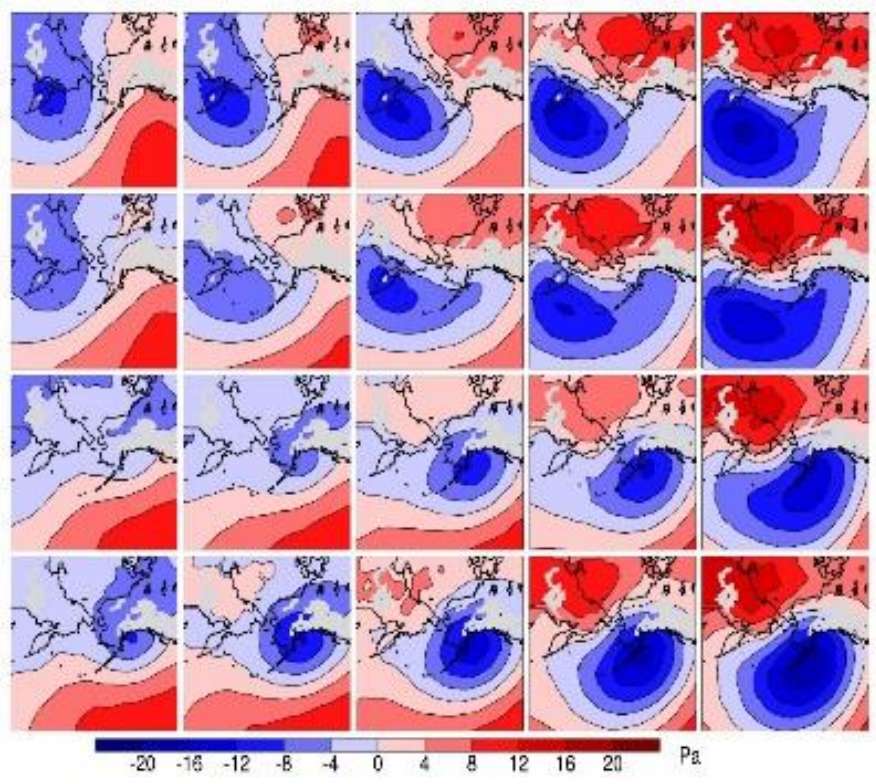
	A	B	C	D	E
1	84.58 **−8.17** 51.30 73 ******	54.21 **−10.68** 52.47 64 −67.53	108.66 **−3.83** 53.42 74 −68.63	51.73 **−2.58** 25.93 73 −35.27	19.78 **−6.63** 13.53 46 −35.96
2	161.09 **7.91** 87.99 57 −87.77	99.69 **−0.37** 44.71 64 −55.64	51.37 **−6.87** 26.26 43 −48.80	28.67 **−7.11** 33.56 45 −64.27	52.48 **5.08** 24.39 38 −21.69
3	159.04 **3.60** 73.54 117 −73.10	79.05 **−15.92** 51.96 42 ******	86.20 **7.29** 46.83 55 −49.43	76.68 **5.45** 46.25 39 −44.93	17.14 **−1.65** 19.24 34 −19.05
4	125.57 **−0.96** 66.53 55 −68.01	155.30 **19.15** 80.58 47 −58.57	88.99 **5.41** 50.32 85 −47.31	62.01 **3.62** 31.44 63 −43.29	67.49 **2.78** 37.05 122 −31.22

Together


-20 -16 -12 -8 -4 0 4 8 12 16 20
Pa


OLIKTOK BARROW (OLI years) BARROW
Temperature anomaly
[C]
LWD anomaly
[W/m²]
PWV anomaly
[cm]
Cloud Fraction anomaly
[%]
Node Frequency (65 years) (Oliktok years)
[%]
(A,1) (B,1) (C,1) (D,1) (E,1) (A,2) (B,2) (C,2) (D,2) (E,2) (A,3) (B,3) (C,3) (D,3) (E,3) (A,4) (B,4) (C,4) (D,4) (E,4)
SOM Node

What does it mean?



- Warm anomalies in OLI/NSA with low over Kamchatka Peninsula, Russia
- Driven by (1) enhanced LWD from warm moist air; (2) enhanced SWD from decreased clouds.
- OLI surface temperature anomalies are strongly correlated with LWD anomalies (0.74), moderately correlated with PWV (0.41), but weakly correlated with cloud occurrence (0.27) or LWP (0.18)
- Future work: more parameters, seasonal aspects, impact of sea ice, "trajectories" through SOM space